CLAIMS

What is claimed is:

1. A method for improving a transmission of a free-space optical communications signal passing through a window having a first imperfect surface including a plurality of non-flat surface voids, comprising:

applying a void-filling material in a non-solid form to the first imperfect surface so as to fill any non-flat surface voids on the first imperfect surface in an area through which the optical communications signal is to pass; and

curing the void-filling material into a solid form such that an outside surface of the void-filling material adjacent to the first imperfect surface is substantially perfectly planar,

wherein the void-filling material is selected to have an index of refraction that substantially matches an index of refraction for the window at an optical wavelength corresponding to the free-space optical communication signal. .

2. The method of claim 1, wherein the void-filling material comprises a liquid that is sprayed over the first imperfect surface.

3. The method of claim 1, wherein the void-filling material comprises a gel that is applied to the first imperfect surface using a brush or roller.

4. The method of claim 1, wherein the wavelength of the free-space optical communications signal is from 700 to 1700 nanometers.

5. The method of claim 1, wherein the window further comprises a second imperfect surface including a plurality of non-flat surface voids, further comprising:

applying the void-filling material to the second imperfect surface so as to fill any non-flat surface voids on the second imperfect surface in an area through which the optical communications signal is to; and

curing the void-filling material into a solid form such that an outside surface of the void-filling material adjacent to the second imperfect surface is substantially perfectly planar.

6. A method for improving a transmission of a free-space optical communications signal passing through a window having a first imperfect surface including a plurality of non-flat surface voids, comprising:

applying a void-filling material to the first imperfect surface so as to fill any non-flat surface voids on the first imperfect surface in an area through which the optical communications signal is to pass; and

mounting a substantially perfect optically translucent plate having an outside surface that is substantially perfectly planar to the first imperfect surface of the window so as to capture the void-filling material between an inside surface of the substantially perfect optically translucent plate and the first imperfect surface of the window,

wherein the void-filling material is selected to have an index of refraction that substantially matches an index of refraction for the window at an optical wavelength corresponding to the free-space optical communication signal.

7. The method of claim 6, wherein the void-filling material comprises a liquid.

8. The method of claim 6, wherein the void-filling material comprises a gel.

9. The method of claim 6, wherein the wavelength of the free-space optical communications signal is from 700 to 1700 nanometers.

10. The method of claim 6, wherein the substantially perfect optically translucent plate is mounted to the first imperfect surface of the window by applying an adhesive between a peripheral area of the

substantially perfect optically translucent plate and an adjacent area in the first imperfect surface of the window.

11. The method of claim 10, wherein the void-filling material is captured between the inside surface of the substantially perfect optically translucent plate and the first imperfect side of the window by:

applying the adhesive to a peripheral area of the inside surface of the substantially perfect optically translucent plate;

applying the void-filling material to an area contained within the peripheral area on the inside surface of the substantially perfect optically translucent plate; and

rapidly rotating the substantially perfect optically translucent plate and holding it so its inside surface mates with the first imperfect surface of the window until the adhesive is able to hold the substantially perfect optically translucent plate in place.

12. The method of claim 10, wherein the adhesive comprises an ultra-violet (UV) curable adhesive that rapidly cures in response to application of UV light.

13. The method of claim 6, wherein the substantially perfect optically translucent plate comprises a type of glass.

14. The method of claim 6, wherein the substantially perfect optically translucent plate comprises a plastic.

15. The method of claim 6, wherein the substantially perfect optically translucent plate includes a protective coating on its outside surface to protect the outside surface from environmental damage.

16. The method of claim 6, wherein the substantially perfect optically translucent plate has a planar cavity defined in its inside surface and wherein the void-filling material is captured between the inside surface of the substantially perfect optically translucent plate and the first imperfect side of the window by:

mounting a peripheral area of the substantially perfect optically translucent plate to the first imperfect surface of the window; and

inserting the void-filling material into the cavity.

17. The method of claim 6, wherein the window further comprises a second imperfect surface including a plurality of non-flat surface voids, further comprising:

applying the void-filling material to the second imperfect surface so as to fill any non-flat surface voids on the second imperfect surface in an area through which the optical communications signal is to pass; and

mounting a second substantially perfect optically translucent plate having an outside surface that is substantially perfectly planar to the second imperfect surface of the window so as to capture the void-filling material between an inside surface of the second substantially perfect optically translucent plate and the second imperfect surface of the window.

18. A method for improving a transmission of a free-space optical communications signal passing through a window having a first imperfect surface including a plurality of non-flat surface voids, comprising:

applying a void-filling material to the first imperfect surface so as to fill any non-flat surface voids on the first imperfect surface in an area through which the optical communications signal is to pass; and

covering the void-filling material with a flexible optically translucent sheet of material so as to capture the void-filling material between an inside surface of the flexible optically translucent sheet of material and the first imperfect surface of the window,

wherein the void-filling material is selected to have an index of refraction that substantially matches an index of refraction for the window at an optical wavelength corresponding to the free-space optical communication signal.

19. The method of claim 18, wherein the void-filling material comprises a liquid.

20. The method of claim 18, wherein the void-filling material comprises a gel.

21. The method of claim 18, wherein the window further comprises a second imperfect surface including a plurality of non-flat surface voids, further comprising:

applying the void-filling material to the second imperfect surface so as to fill any non-flat surface voids on the second imperfect surface in an area through which the optical communications signal is to pass; and

covering the void-filling material that is applied to the second imperfect surface with a second flexible optically translucent sheet of material so as to capture the void-filling material between an inside surface of the second flexible optically translucent sheet of material and the second imperfect surface of the window.

22. An apparatus for improving a transmission of a free-space optical communications signal passing through a window having a first imperfect surface including a plurality of non-flat surface voids, comprising:

a void-filling material that is applied in a non-solid form to the first imperfect surface so as to fill any non-flat surface voids in an area on the first imperfect surface through which the optical communications signal is to pass and cured into a solid form such that an outside surface of the void-filling material adjacent to the first imperfect surface is substantially perfectly planar,

wherein the void-filling material is selected to have an index of refraction that substantially matches an index of refraction for the window at an optical wavelength corresponding to the free-space optical communication signal.

23. The apparatus of claim 22, wherein the wavelength of the free-space optical communications signal is from 700 to 1700 nanometers.

24. The apparatus of claim 22, wherein the window further comprises a second imperfect surface including a plurality of non-flat surface voids to which the void-filling material is also applied so as to fill any non-flat surface voids in an area on the second imperfect surface through which the optical communications signal is to pass, said void-filling material being cured into a solid form such that an outside surface of the void-filling material adjacent to the second imperfect surface is substantially perfectly planar.

25. An apparatus for improving a transmission of a free-space optical communications signal passing through a window having a first imperfect surface including a plurality of non-flat surface voids, comprising:

a void-filling material that is applied to the first imperfect surface so as to fill any non-flat surface voids in an area on the first imperfect surface through which the optical communications signal is to pass; and

a substantially perfect optically translucent plate having an outside surface that is substantially perfectly planar, which is mounted to the first imperfect surface of the window so as to capture the void-filling material between an inside surface of the substantially perfect optically translucent plate and the first imperfect surface of the window,

wherein the void-filling material is selected to have an index of refraction that substantially matches an index of refraction for the window at an optical wavelength corresponding to the free-space optical communication signal.

26. The apparatus of claim 25, wherein the void-filling material comprises a liquid.

27. The apparatus of claim 25, wherein the void-filling material comprises a gel.

28. The apparatus of claim 25, wherein the wavelength of the free-space optical communications signal is from 700 to 1700 nanometers.

29. The apparatus of claim 25, wherein the substantially perfect optically translucent plate is mounted to the first imperfect surface of the window by means of an adhesive that is disposed between a peripheral area of the substantially perfect optically translucent plate and the first imperfect surface of the window.

30. The apparatus of claim 29, wherein the adhesive comprises an ultra-violet (UV) curable adhesive that rapidly cures in response to application of UV light.

31. The apparatus of claim 25, wherein the substantially perfect optically translucent plate comprises a type of glass.

32. The apparatus of claim 25, wherein the substantially perfect optically translucent plate comprises a plastic.

33. The apparatus of claim 25, wherein the substantially perfect optically translucent plate includes a protective coating on its outside surface to protect the outside surface from environmental damage.

34. The apparatus of claim 25, wherein the substantially perfect optically translucent plate has a planar cavity defined in its inside surface and wherein the void-filling material is captured between the inside surface of the substantially perfect optically translucent plate and the first imperfect side of the window by inserting the void-filling material into the cavity.

35. The apparatus of claim 25, wherein the window further comprises a second imperfect surface including a plurality of non-flat surface voids to which the void-filling material is also applied so as to fill any non-flat surface voids in an area on the second imperfect surface through which the optical communications signal is to pass, further comprising:

a second substantially perfect optically translucent plate having an outside surface that is substantially perfectly planar, which is mounted to the second imperfect surface of the window so as to capture the void-filling material between an inside surface of the second substantially perfect optically translucent plate and the second imperfect surface of the window.

36. An apparatus for improving a transmission of a free-space optical communications signal passing through a window having a first

imperfect surface including a plurality of non-flat surface voids, comprising:

a void-filling material that is applied to the first imperfect surface so as to fill any non-flat surface voids in an area on the first imperfect surface through which the optical communications signal is to pass; and

a flexible optically translucent sheet of material that is applied over the area occupied by the void-filling material so as to capture the void-filling material between an inside surface of the flexible optically translucent sheet of material and the first imperfect surface of the window,

wherein the void-filling material is selected to have an index of refraction that substantially matches an index of refraction for the window at an optical wavelength corresponding to the free-space optical communication signal.

37. The apparatus of claim 36, wherein the void-filling material comprises a liquid.

38. The apparatus of claim 36, wherein the void-filling material comprises a gel.

39. The apparatus of claim 36, wherein the window further comprises a second imperfect surface including a plurality of non-flat surface voids to which the void-filling material is also applied so as to fill

any non-flat surface voids in an area on the second imperfect surface through which the optical communications signal is to pass, further comprising:

a second flexible optically translucent sheet of material that is applied over the area occupied by the void-filling material on the second imperfect surface so as to capture the void-filling material between an inside surface of the second flexible optically translucent sheet of material and the second imperfect surface of the window.

40. The apparatus of claim 36, wherein the wavelength of the free-space optical communications signal is from 700 to 1700 nanometers.